

Budget-in-Brief

Fiscal Year 2000



Science, Security and Energy: *Powering the 21st Century*



Office of Fossil Energy
U.S. Department of Energy

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Introduction

America's economic engine remains the envy of the world. The major fuels powering our nation's economic growth remain fossil fuels – coal, petroleum and natural gas – which supply more than 85 percent of the energy consumed in the United States. The relatively low cost of these fuels and, particularly for coal and natural gas, their domestic abundance are largely responsible for the vitality of our economy. Despite their dominance, however, if these fuels are to continue to fuel economic growth, several challenges must be met:

Petroleum – Over the past two years, crude oil prices have dropped by more than 40 percent. Adjusted for inflation, the price of a barrel of oil is at its lowest value since the Great Depression of the 1930s. This is an industry on which we depend both strategically and economically, yet net oil imports now account for a record 49% of consumption and could reach 65% by 2020 or possibly more than 70% if low prices persist. For many domestic operators, it now costs more to produce oil than the producer receives in revenue and, largely as a result, an estimated 49,000 domestic wells were taken out of production in just the first half of 1998, compared with only 15,000 wells plugged in all of 1997. Nearly 11,000 jobs were lost, primarily in smaller independent companies that are now the mainstays of the domestic petroleum industry.

A combination of actions will be necessary to sustain production from some of our most endangered oil fields, especially from our 430,000 marginal wells. But one of the most significant actions will be to develop lower-cost, more effective exploration and production tools. Improved oil field technologies can mean the difference between continued production and premature shut-in of wells that remain vital to our energy future.

What is Possible...

If we sustain a commitment to the programs
In the FY2000 Fossil Energy budget:

- \$5 billion per year in environmental cost savings at U.S. power plants through 2010, and \$7 billion per year after 2010;
- \$16 billion in cumulative cost savings for oil and gas environmental compliance by 2010;
- \$5 to \$15 billion per year in savings in the cost of electricity through at least 2030;
- A 60% efficient coal plant that emits 45% less CO₂ by 2010, and the potential for a revolutionary "zero emissions" plant in the post-2010 time frame;
- The world's most advanced gas turbine with 60% efficiencies and ultra-low NO_x emissions by 2002;
- A multi-megawatt fuel cell for the distributed power market with near zero emissions of priority pollutants by 2003;
- More than 2 trillion cubic feet/year of *additional* natural gas production by 2010;
- 500,000 barrels per day of additional domestic oil production, primarily from smaller independent producers, by 2010;
- The capability to produce liquid fuels from remote gas deposits with a commercial-scale gas-to-liquids plant on Alaska's North Slope by 2008; and
- A streamlined Strategic Petroleum Reserve fully capable for the next quarter century of supplying an initial 4.2 million barrels per day of emergency crude oil at the direction of the President.

Natural Gas – The nation’s natural gas industry is facing the likelihood of a 33% increase in demand over the next decade. Even without possible climate change actions, U.S. gas consumption, now at 22 trillion cubic feet (TCF) per year, could grow to nearly 35 TCF by 2020 if economic expansion is strong. Yet, questions have been raised as to whether the industry can meet the steady growth in demand and, at the same time, keep prices reasonable. The current price situation in the oil patch can influence the future supply of gas, since much of the nation’s gas is produced by the same companies that produce oil.

In many existing fields, natural gas has been bypassed by conventional exploration and production technologies. Better imaging and other detection technologies, new drilling and stimulation tools, and more effective production approaches can increase the flow of natural gas from these known fields. Improved, lower cost technologies for removing impurities can upgrade the more than one-quarter of our domestic gas supply that is below pipeline quality. New gas-to-liquids conversion methods can turn currently unmarketable gas resources into future supplies of valuable energy. Beyond 2015, natural gas from traditional resources may begin to taper off. The nation will likely have to turn increasingly to non-traditional gas sources locked in even more complex, harder-to-produce formations, such as deep gas and, in the longer-term, possibly methane hydrates.

Coal – Although coal is the most abundant and lowest cost energy form in the United States and in many other countries, it is also a major source of both traditional pollutants and greenhouse gases. Particularly in the electric power generation sector, where coal supplies 56% of the nation’s electricity, improvements in environmental performance and generating efficiency will be necessary if the nation is to continue to benefit from the economic advantages of coal. Improved technology has already allowed the nation’s coal burning power plants to cut annual sulfur dioxide emissions by more than half from 1980 levels and to reduce nitrogen oxide emissions by more than 40% since 1990. Yet, further technological improvements will be necessary to meet the Government’s new smog and fine particulate standards and possibly, new requirements for air toxic emissions. Land constraints will increase the need to reduce solid wastes. Pressures will increase to find economically acceptable ways to reduce both emissions and atmospheric concentrations of greenhouse gases.

A combination of ultra-high efficiency technologies and low-cost carbon capture and disposal technologies could make it possible to significantly reduce, if not eliminate, these environmental concerns over coal use and permit the nation to continue to prosper from coal’s economic benefits. Technology now appears within reach that can double today’s power plant efficiencies, virtually eliminate air emissions, release no net carbon dioxide, and still produce power that is low enough in cost to be competitive with the best of today’s pulverized coal plants. It may also be possible to use coal in an integrated “energy complex” to produce high-grade, low-polluting transportation fuels that, coupled with improve engine technology, could double fuel combustion efficiency and further reduce air emissions from the transportation industry.

To help the U.S. energy industry take advantage of these opportunities, the Administration’s FY2000 Fossil Energy budget proposes the following funding levels:

Office of Fossil Energy - FY 2000 Budget (in thousands of dollars)

| | FY 1998 Approps | FY 1999 Approps | FY 2000 Request | Change (FY98-99) |
|--|----------------------------|----------------------------|----------------------------|-----------------------------|
| Coal | | | | |
| - Advanced Clean, Efficient Power Systems | \$72,420 | 87,676 | 84,737 | -2,939 |
| - Advanced Clean Fuels | 15,559 | 15,528 | 14,500 | -1,028 |
| - Advanced Research & Technology Development | <u>17,312</u> | <u>19,939</u> | <u>23,195</u> | <u>+3,256</u> |
| <i>Subtotal, Coal</i> | 105,291 | 123,143 | 122,432 | -711 |
| Natural Gas | | | | |
| - Natural Gas Supply | 25,430 | 26,507 | 25,857 | -650 |
| - Advanced Gas Turbines | 43,875 | 44,500 | 41,808 | -2,692 |
| - Fuel Cells | <u>39,156</u> | <u>44,200</u> | <u>37,649</u> | <u>-6,551</u> |
| <i>Subtotal, Natural Gas</i> | 108,461 | 115,207 | 105,314 | -9,893 |
| Petroleum | | | | |
| - Oil Technology | 47,708 | 48,616 | 50,166 | +1,550 |
| Other Fossil Energy R&D and Activities | | | | |
| - Cooperative Research and Development | 5,686 | 6,836 | 5,836 | -1,000 |
| - Advanced Metallurgical Processes | 4,965 | 5,000 | 5,000 | -- |
| - Environmental Restoration | 12,935 | 11,000 | 10,000 | -1,000 |
| - Fossil Fuels Regulatory Programs | <u>2,173</u> | <u>2,173</u> | <u>2,173</u> | <u>--</u> |
| <i>Subtotal, Other</i> | 25,759 | 25,009 | 23,009 | -2,000 |
| R&D Headquarters/Field Management and Plant & Capital Equipment | 69,362 | 72,081 | 74,079 | +1,998 |
| Prior Year Offsets | | | | |
| - From Fossil Energy R&D Program | -64 | 0 | -11,000 | -11,000 |
| <i>Subtotal, Fossil Energy R&D</i> | 356,517 | 384,056 | 364,000 | -20,056 |
| Clean Coal Technology Demonstration Program | -101,000 | -40,000 | -246,000 | -206,000 |
| Strategic Petroleum Reserve | | | | |
| - Facilities Management | 207,500 | 160,120 | 159,000 | -1,120 |
| - Petroleum Logistics | <u>0</u> | <u>0</u> | <u>5,000</u> | <u>+5,000</u> |
| <i>Subtotal, Strategic Petroleum Reserve</i> | 207,500 | 160,120 | 164,000 | +3,880 |
| Naval Petroleum & Oil Shale Reserves | | | | |
| - Operations and Management | 107,000 | 14,000 | 0 | -14,000 |
| - Elk Hills School Lands Fund | 0 | 36,000 | 36,000 | -- |
| Alternative Fuels Production (Interest) | -1,500 | -1,300 | -1,000 | +300 |
| TOTAL, FOSSIL ENERGY PROGRAM | \$568,517 | \$552,876 | \$317,000 | -235,876 |

Advanced Clean, Efficient Power Technologies

The low cost of America's abundant coal supplies is one of the reasons why the United States benefits from the lowest electricity rates of any free market industrialized country. Yet, a host of new environmental requirements could add significantly to the future cost of generating electricity from coal and, in turn, to costs borne by the nation's ratepayers. Better technology can significantly reduce these costs while continuing to protect the environment. For example, if current technologies are used to meet additional Environmental Protection Agency air quality standards, as much as \$14 billion per year could be added to the nation's electricity rates by 2010. *DOE's R&D program has the potential to cut the added costs in half.*

In the post-2010 era, a new wave of power plant construction and modernization is also likely as the nation's economy continues to grow. Advanced technology is in sight that can enable this new fleet of power stations to virtually eliminate all harmful emissions, including greenhouse gases, while continuing to be fueled by coal. After a year of "roadmapping," stakeholder input, and preliminary studies, the FY2000 program moves into the early stages of engineering designs and development of key modules for this new fleet of central and distributed power facilities – a concept we have termed the *Vision 21 PowerPlex*.

Our Performance Goals for Power Technologies R&D in FY2000 Include:

- Begin construction of an advanced low-emission boiler power facility that will achieve superior environmental performance and enhanced efficiencies,
- Verify high temperature air furnace for use in indirectly fired cycles and potentially in *Vision 21* power plants,
- Provide to regulatory agencies and industry detailed, high quality data on the "fingerprints" of microscopic airborne particles (PM2.5) as well as cost-effective emission control technologies.

Elements of the Fossil Energy program, such as fuel-flexible gasifiers, advanced turbines, fuel cells, fuel cell/turbine hybrids, advanced steam bottoming cycles, and innovative liquid synthesis processes, form the nucleus of the *Vision 21* concept. The goal is a 60%-efficient power plant with the flexibility to produce power along with premium fuels and chemicals, incorporate industrial process heat generation, and boost overall thermal efficiencies to as high as 85% or more, reducing carbon emissions by more than 62%. Equipped with carbon capture devices, *Vision 21* units would be virtually "zero discharge" plants. "Enabling technologies," such as new membranes for separating oxygen and hydrogen, high-temperature heat exchangers, new gas stream purification systems, etc., are being developed as part of the *Vision 21* effort. Critical research, ranging from high-strength materials to advanced computer models that provide "virtual demonstrations" of future power generation and fuel conversion processes, is included in the FY2000 budget to undergird the *Vision 21* concept.

In parallel with this effort, the FY2000 budget includes R&D on other innovative combustion and environmental technologies. Construction of a new low emission boiler system will begin, and R&D support will continue for several first-of-a-kind Clean Coal Technology projects.

Another high-priority effort in the FY2000 program is expanded research on carbon sequestration. Sequestration – advanced methods for capturing and permanently disposing of greenhouse gases – may be the single most important research initiative for the future of coal and other fossil fuels. *It is the only option for addressing climate change that is completely compatible with the current energy infrastructure.* DOE's Fossil Energy Program is approaching carbon sequestration as a research challenge, a way to provide future options should climate change response measures be enacted in the future. The possibilities are enormous – if low cost sequestration can be developed, it would be theoretically possible to sequester *all* human-caused carbon emissions (7 billion tons currently emitted; 10-14 billion tons per year projected for 2050). Yet, there remain major uncertainties that can be answered only with exploratory research. Particularly challenging is DOE's aggressive cost target of \$10 per ton of carbon, which if achieved, *could save the United States hundreds of billions of dollars compared to current alternatives.*

The major budget categories of the Advanced Clean, Efficient Power Systems Program are:

Low Emission Boiler System ***FY1999 - \$15.00 million*** ***FY2000 - \$3.0 million***

- The FY2000 budget completes funding for the final development of this advanced pulverized coal combustion technology with DB Riley Inc. scheduled to begin construction of an 80-megawatt proof-of-concept unit in Illinois.

Indirectly Fired Cycle ***FY1999 - \$ 6.50 million*** ***FY2000 - \$7.01 million***

- Foster Wheeler Corp. and United Technologies will continue development of this innovative concept that incorporates a high temperature advanced furnace to heat a clean working fluid (air) to drive a gas turbine and when integrated with fuel cells is a candidate *Vision 21* concept.

Integrated Gasification

Combined Cycle ***FY1999 - \$32.39 million*** ***FY2000 - \$38.66 million***

- The FY2000 focus will be on developing *Vision 21*-tailored coal gasification techniques that can handle multiple fuel forms and produce gases for power generation and fuels/chemical synthesis. With much of the work taking place at the Wilsonville (AL) Power Systems Development Facility and the University of North Dakota Energy & Environmental Research Center, R&D will be carried out to reduce the formation of air toxic pollutants, improve gas separation and cleaning technologies, and integrate coal gasification with possible carbon sequestration approaches. Also, fuel cell development in support of *Vision 21* will be conducted.

Pressurized Fluidized

Bed Combustion ***FY1999 - \$14.64 million*** ***FY2000 - \$12.20 million***

- This advanced process, which incorporates sulfur capture and nitrogen oxide reduction in a high-efficiency coal burning process, is envisioned as a core combustion technology for *Vision 21*. In FY2000, primarily at the Wilsonville (AL) Power Systems Development Facility, pilot scale tests will be conducted of “2nd generation” concepts to provide R&D data for ongoing Clean Coal Technology Demonstration projects. Studies will also be carried out on advanced hot gas filter materials and sulfur sorbents that release less carbon dioxide, and test firings will be conducted on fuels that mix coal with carbon neutral feedstocks to reduce CO₂ emissions.

Advanced Research and

Environmental Technology

FY1999 - \$19.15 million

FY2000 - \$28.86 million

- The major increase in the FY2000 budget is to support an expanded exploratory research program for low-cost carbon sequestration concepts (FY1999 - \$5.89 million; FY2000 - \$9.13 million). In FY2000, several innovative concepts will be ready for the first stages of engineering scale development and geologic field tests. Also, R&D will continue on more effective ways to retrofit existing power plants to reduce nitrogen oxides (to meet new Clean Air standards) and to control the release of microscopic particles (PM2.5) and air toxics. Waste management R&D will also continue to ensure that any solid wastes from advanced coal systems can be safely disposed of or converted into marketable products.

Advanced Clean Fuels Research

Liquid hydrocarbons will continue to be important transportation fuels well into the next century, both in developed nations and increasingly, in developing countries. The U.S. transportation sector relies on liquid fuels for 97% of its fuel requirements. Not only are future liquid fuels an energy security concern, the use of traditional petroleum-based fuels in the transportation sector accounts for a large portion of urban air pollution, including 81% of carbon monoxide, 49% of nitrogen oxides, and 37% of volatile organic compounds. The transportation fleet also contributes 1/3rd of U.S. carbon dioxide emissions and could account for 40% of these emissions by 2020. Developing innovative processes to produce coal-based transportation fuels, chemicals and carbon products provides an insurance policy against future supply problems, and the potential to achieve high combustion efficiencies and ultra-low fuel emissions from coal-based alternative liquids can play an important role in meeting 21st century environmental goals.

New technologies that enhance the precombustion characteristics of coal can help reduce the release of hazardous air pollutants and convert unused carbon now discarded from coal operations into future energy feedstocks. Advanced technologies can also create new options for producing high-value carbon products from coal for structural materials and high-purity carbon for 21st century industries. The major elements of the FY2000 Advanced Clean Fuels Research Program are:

Coal Preparation

FY1999 - \$5.10 million

FY2000 - \$4.00 million

- In FY2000 this program completes its transition to a broader-based R&D effort to produce solid fuels and feedstocks. As in prior years, R&D will continue on ways to pretreat coal to remove impurities that can form air toxics and other pollutants, but work will also extend into new areas including the preparation of combined coal/biomass/waste fuels, the recovery of previously discarded carbon raw materials from waste piles and ponds, and the development of new technologies for producing premium carbon and coal-based industrial products.

Direct and Indirect Liquefaction

FY1999 - \$8.65 million

FY2000 - \$8.30 million

- Restructuring of these programs will continue in FY2000 with increased emphasis on advanced, low cost indirect liquefaction that convert coal-derived gases into clean diesel fuels (no sulfur or aromatics) and premium chemicals. A new effort will study ways to integrate coal-to-liquids processing with electric power generation using existing infrastructure. R&D will also be continued, at a reduced level, on advanced concepts for converting coal directly into liquid fuels.

Advanced Research and

Environmental Technology

FY1999 - \$1.78 million

FY2000 - \$2.20 million

- This activity in FY2000 will support several exploratory concepts, such as research to identify liquid fuels that might be suitable as chemical storage agents for hydrogen and could be used in fuel cell powered vehicles. Molecular modeling efforts that simulate the growth of carbon structures and the interactions between molecules will be carried out to help design better energy and industrial catalysts.

Advanced Research and Technology Development

The Advanced Research and Technology Development (AR&TD) program funds two types of activities: 1) long-range research and studies that provide the technological foundation for future *coal-related* systems and 2) more generic research, analyses, and technical support that can be applied to all fossil energy technologies.

Coal-Related Advanced Research

FY1999 - \$9.16 million

FY2000 - \$11.45 million

- Having completed its transition in FY1999 from a primary emphasis on basic coal combustion research to an expanded effort to identify and resolve critical barriers to the *Vision 21* concept, this effort in FY2000 will include research on intriguing concepts for CO₂ capture such as artificially stimulating mineral growth and the use of advanced computing concepts to create “virtual demonstrations” of *Vision 21* processes. Research will also be done to apply advanced biological techniques to solve key challenges in producing clean, coal-based fuels. In FY2000 pilot scale efforts will continue in the conversion of coal-derived gases into ethanol, the removal of nitrogen oxides using biofiltration techniques, and biological CO₂ sequestration.

This funding also includes support for the University Coal Research Program (FY1999 - \$2.9 million; FY2000 - \$3.0 million) which provides grants to student-professor research teams to carry out fundamental coal science and technology studies.

Fossil Energy-Wide

Crosscutting R&D

FY 1999 - \$10.78 million

FY2000 - \$11.75 million

- FY2000 funding will support the development of high-performance materials that can be used for structural elements of future *Vision 21* plants or other energy facilities and for advanced gas separation and particulate control filters. Research will also continue on better instrumentation and diagnostics that can lead to improved controls and sensors for advanced energy processes.

Support for fossil energy research at Historically Black Colleges and Universities and other minority institutions is also part of this budget category (FY 1999 - \$900,000; FY2000 - \$1.0 million). Also included is support for crosscutting environmental, technical and economic analyses and international programs.

Natural Gas Supply Research

In all cases in the Energy Information Administration’s recent *Annual Energy Outlook - 1999*, natural gas consumption continues its steep rise, reaching nearly 30 trillion cubic feet (TCF) per year by 2020 in the low economic growth case to almost 35 trillion cubic feet per year if

economic growth is high (current consumption is 22 trillion cubic feet per year). Should emission targets be enacted for greenhouse gases, the upward trend in gas demand could be even more pronounced in the post-2010 timeframe, perhaps pushing gas demand to 40 trillion cubic feet or more per year.

At the same time, however, natural gas reserves-to-production ratios have been declining in North America since 1986. New fields are smaller than their predecessors, and improved technologies deplete them faster than in the past. Proven reserves in the Gulf of Mexico, which account for almost one-quarter of U.S. gas production, continue to fall.

The challenge for the coming century will be to develop an adequate gas supply resource base and the necessary infrastructure to meet a 30 TCF-plus market and, at the same time, keep gas prices reasonable. Future gas supplies will likely come increasingly from today's immature and undiscovered resources. As gas demand grows in the next two decades and conventional gas resources continue to decline, gas from deeper and denser formations and potentially, gas from hydrates could become important new sources of this clean-burning, versatile fuel.

New technology is the key to unlocking these future resources; however, R&D expenditures by industry and the Gas Research Institute, which is undergoing a major transition to an all-voluntary funding basis, are declining. The federal natural gas research program is now the only national effort providing a consistent level of support for future gas exploration, production, and processing technologies.

In FY2000, the major elements of this program will include:

Exploration and Production **FY1999 - \$13.43 million** **FY2000 - \$14.93 million**

- The majority of R&D in this category continues efforts begun in prior years to 1) develop and field test new technologies, such as slimhole and underbalanced drilling, that are faster and less damaging to gas-bearing formations, 2) study advanced fluid fracturing techniques using the unique facilities and expertise at the University of Oklahoma, 3) improve techniques for imaging and predicting gas production in naturally fractured reservoirs, 4) study the potential for deep gas production in priority basins, 5) support industry-national laboratory partnerships in new gas technologies, 6) examine ways to revitalize production from gas stripper wells, and 7) continue work to produce missed or bypassed ("secondary") gas from formations in the Appalachian Basin and the Gulf Coast offshore.

One area where increased funding is requested is for the study of methane hydrates (FY1999 - \$500,000; FY2000 - \$1.99 million). Methane hydrates — natural gas molecules encased in ice crystals — is a potentially vast, global gas resource, with resource estimates that are more than 5000 times the world's currently recoverable gas reserves. After a year of developing a multi-agency methane

Our Performance Goals for Natural Gas Supply R&D in FY2000 Include:

- *Demonstrate the cost-effective productivity of horizontal wells in fractured, low permeability formations for which vertical wells are uneconomic, increasing recovery of the approximately 5,000 TCF currently uneconomic in the Greater Green River Basin of Wyoming, Colorado, and Utah.*

hydrates program strategy, the FY2000 budget would increase funding for DOE's share of research in such areas as resource characterization, production, and safety and seafloor stability.

Delivery and Storage

FY1999 - \$1.00 million

FY2000 - \$1.00 million

- As gas demand grows, reliable, cost-effective storage of natural gas will remain key to customer confidence in gas supplies. Depleted oil and gas reservoirs are used for interim storage of natural gas primarily to meet seasonal increases in gas demand during the winter. Each reservoir has characteristics that determine how fast gas can be injected and withdrawn and the total amount of gas that can be effectively stored. R&D is necessary to improve storage methodologies and technologies to prevent a loss of deliverability from these fields and to better remediate lost deliverability when it occurs. In FY2000, DOE will continue its R&D efforts with industry to develop advanced storage technologies, novel and improved fracture simulation techniques and better remediation efforts to offset today's annual losses in deliverability. Work will also continue to improve gas metering (such as ultrasonic metering) that can provide real time, automated data on pipeline gas flow.

Emerging Processing

Technology Applications

FY1999 - \$9.06 million

FY2000 - \$7.31 million

- Development of a lower cost method to convert natural gas to liquid fuels remains a high priority in this budget area with R&D in FY2000 continuing in the 3rd year of an 8-year program to develop ceramic membrane technology for the conversion process. If this R&D is successful, gas-to-liquid costs could be reduced by 25-35% into a range of \$18-22 per barrel, improving prospects for applying the technology to prolong the life of the Trans-Alaska Pipeline and increase gas production from remote locations in the Gulf of Mexico.

R&D also will continue in FY2000 to improve upgrading technologies to reduce polluting contaminants that make as much as 1/3rd of the nation's gas resources unsuitable for pipeline transport unless the impurities are removed. An important aspect of this research also applies to the often-ignored gas released from coal mining. Support is also provided in this category for the International Center for Gas Technologies.

Effective Environmental

Protection

FY1999 - \$3.02 million

FY2000 - \$2.62 million

- In recent years, environmental concerns have led to numerous Federal and State regulations being imposed on oil and gas operations in the United States. The increasingly higher costs of environmental compliance — now amounting to nearly \$10 billion a year for the oil and gas industry, including refining — places a substantial economic burden on producers, particularly in times of low oil and gas prices. DOE's efforts in FY2000 will be to continue efforts with Federal and State agencies to reduce overlapping and sometimes outdated regulations that can add unnecessary costs, and to develop lower-cost environmental technologies — for example, to treat and dispose of naturally occurring radioactive material (NORM) from oil and gas operations.

Advanced Gas Turbines

The United States now has in sight an advanced gas turbine that will surpass any other utility-scale turbine offered in the world. The FY2000 budget represents the last *major* funding year (FY2001, at a lower level, will be the final funding year) in an 8-year program to produce

working prototypes of a natural gas turbine for baseload power generation that will be 10% more efficient and will produce less than half the nitrogen oxides of current gas turbine systems.

The likely benefits of this program are enormous. The Energy Information Administration estimates that gas turbines will satisfy as much as 81 percent of new electric power demands in the U.S. by the year 2010. More than 70 percent of all new power generation equipment installed in the U.S. after the year 2000 is forecast to be derived from the DOE Advanced Turbine Systems program. Because the advanced turbine systems will produce lower cost electricity than currently

available technology (around 2.6 cents per kilowatt-hour), U.S. consumers stand to save an estimated \$7 billion in electricity costs by 2015 because of our investment in this “next generation” turbine system. Billions more will be saved in reduced environmental compliance costs due to the low emission characteristics of these new systems.

Our Performance Goals for Advanced Gas Turbines in FY2000 Include:

- *Complete validation testing for critical components of advanced utility-scale turbines with over 60% efficiency and ultra-low Nox emissions. Initiate advanced gas turbine full speed, no load testing as the last step before demonstration by industry.*

In FY2000, the Advanced Turbine Systems (ATS) Program will include:

Major Systems Development* *FY1999 - \$35.49million* *FY2000 - \$32.59 million

- In FY2000 the two turbine developers that entered into the final phase of the utility scale advanced turbine program will complete ATS component/subsystem testing and initiate engine manufacturing. One manufacturer will begin the first full-speed, no-load testing, while both developers will begin work on integrating the turbine technology into a fully-capable power plant configuration. The ATS power plant demonstration will be privately financed and will require no cost-sharing from DOE.

Technology Base Research* *FY1999 - \$8.57 million* *FY2000 - \$8.00 million

- Support work will continue at universities and in-house to assist in the final stages of development and testing of the prototype units (above), but emphasis will begin to shift to evaluating future advancements in turbine systems.

Vision 21 Support* *FY1999 - \$0* *FY2000 - \$0.80 million

- With advanced turbines figuring prominently in the *Vision 21* concept, work will begin in FY2000 to study ways to enhance the fuel flexibility of future advanced turbine systems, including their adaptability to coal-based technologies.

Fuel Cells

Cost reductions and performance improvements continue to be the major emphasis of DOE's program to develop stationary power fuel cells. If costs can be brought into the \$1,000-\$1,200 per kilowatt range, the inherently clean, highly efficient performance of fuel cells should make them attractive options, particularly for distributed power applications. Because they rely on an electrochemical reaction — much like a battery — rather than on combustion to generate power

and heat, fuel cells will be ideally suited for urban, environmentally constrained regions. At the same time, because they can be packaged as virtually self-contained, natural gas-powered power units, they may also be attractive in remote settings far from the power grid.

The Office of Fossil Energy's fuel cell efforts in FY2000 will continue to include the development of both molten carbonate and solid oxide technologies. For molten carbonate technology, commercial prototype systems, which reconfigure the cells stacks and power processing modules into more compact, lower cost packages, are being readied for testing in FY1999 and FY2000.

Our Performance Goals for Fuel Cells in FY2000 Include:

- *Begin testing first market prototype solid oxide fuel cell in a commercial setting for combined heat and power applications;*
- *Deliver a 250-kilowatt fuel cell/turbine hybrid power plant to verify possible market entry design for distributed power generation and, in the longer term, provide a building block for Vision 21 systems.*

The solid oxide effort continues through progressively larger prototype units with FY2000 representing the 3rd year of a planned 5-year development effort. In FY1999, a 250-kilowatt fuel cell/microturbine test will be initiated, and testing will continue into FY2000. A particular emphasis is to develop pressurized ceramic tube technology. Development to this point has concentrated on atmospheric pressure systems for combined heat and power; pressurized systems would be more suitable for fuel cell/turbine hybrid configurations for distributed generation.

In FY2000, the major elements of the Fossil Energy fuel cell program will include:

System Development/Vision 21 FY1999 - \$41.00 million FY2000 - \$36.45 million

- Performance improvements and cost reduction R&D will continue with two molten carbonate system developers and one solid oxide system developer. (Fuel cells development for *Vision 21* is also being conducted under the Integrated Gasification Combined Cycle Program in the Coal R&D program.)

Advanced Research FY1999 - \$1.20 million FY2000 - \$1.20 million

- Research will continue on ways to lower fuel cell costs, including studies of new high performance, lower cost ceramic designs and processes. Fundamental work will also be conducted to address crosscutting materials and design issues, and early-stage development of thin film advanced cell processing techniques will continue.

Petroleum

The United States is a mature oil-producing region; domestic production is more difficult and more expensive than overseas production. For every barrel of crude oil produced in this country, two barrels have been left behind, but much of this oil is beyond the capabilities of current technology. Even more oil remains locked in deep, complex reservoirs or in environmentally sensitive areas where high costs of operation and environmental compliance place U.S. producers at a competitive disadvantage with foreign producers.

At the same time, America's appetite for petroleum continues to grow. The *1999 Annual Energy Outlook*, produced by the Energy Information Administration, forecasts that the demand for petroleum products, mainly for transportation, will grow faster than any other aspect of primary energy consumption through at least the year 2020.

Even with advances in oil technology, U.S. oil production could decline from the current 6.4 million barrels per day to 4.9 million barrels per day by 2020, and oil imports could contribute more than \$135 billion to the nation's trade deficit by 2020 as a result.

These ominous trends could be even more severe if oil prices remain low — as current projections indicate — and private sector R&D declines even more precipitously than it has. A major reason for this is the fundamental change that has occurred in the make-up of the domestic petroleum industry. The days of "Big Oil" dominating the U.S. petroleum sector are over; today, it is the independent company — which typically employs less than 20 people — that drills almost all of the wells and produces almost half the oil and nearly two-thirds of the nation's natural gas. These small producers lack the capital to support major R&D projects, and few — especially in the current price climate — are likely to take on the risks of applying advanced, unproven technologies without some type of risk-sharing and technical assistance. For many, the DOE R&D program, with its emphasis on technology transfer, may be the only way they can acquire the tools and techniques to survive.

Our Performance Goals for Petroleum R&D in FY2000 Include:

- *Completing demonstration and transfer of 7 advanced secondary and tertiary recovery technologies, adding 92 million barrels of reserves, increasing the number of economic wells and reducing abandonment rates.*
- *Completing field testing and monitoring of two technologies for downhole separation of oil and water, resulting in a significant reduction in produced waster and potential increase in oil production per well.*

The Petroleum program takes on added emphasis given the current state of the domestic oil industry. In FY2000, this program will include:

Recovery Field Demonstrations FY1999 - \$7.80 million FY2000 - \$7.80 million

- Because of the jointly funded, government-industry *Reservoir Class Field Demonstration Program*, the United States has more than 500 million barrels of crude oil either being produced or now added to its recoverable reserves that likely would have been abandoned otherwise. In FY2000, DOE will try to further capitalize on the prospects for additional oil production by providing a second year of funding in a program to "revisit" geologic classes of reservoirs that still contain large amounts of recoverable oil but face prospects of near-term abandonment, particularly with oil prices at their current levels. The funding (FY1999:\$7.1 million; FY2000: \$6.6 million) will provide up to 35% of the costs of 10-20 projects to be selected in FY1999. To further assist small producers, the FY2000 budget also would target funding (FY1999: \$660,000; FY2000: \$600,000) to help companies with less than 20 employees solve specific field production problems or adopt improved reservoir management practices.

The major increase in funding in this category in FY2000 is for a new effort to help slow the decline in domestic oil production by undertaking a targeted, aggressive regional technology transfer program — an initiative to make direct contact with as many producers as possible to provide them with improved technology in ways they can most easily used. Termed PUMP — for *Preferred Petroleum Upstream Management Practices* — this initiative will enlist the nation’s leading oil technology experts in a coordinated effort with States and expert technology providers to convey to producers and States 1) “best practices” guidelines, 2) problem solving and regulatory streamlining approaches for environmental compliance, such as on-line permitting, and 3) improved tools and techniques through enhanced “face-to-face” technology transfer. (FY1999 - \$0; FY2000 - \$0.5 million.)

Exploration and Production

Supporting Research

FY1999 - \$30.80 million

FY2000 - \$31.55 million

- This effort in FY2000 will continue to develop the advanced imaging, drilling and production tools that can find and recover oil in deeper, more geologically complex, or smaller and more compartmentalized reservoirs. Work will continue in advanced seismic technology, much of it carried out by industry and national laboratory development teams and a major part of it focused on the potentially large new discoveries that could be made below the salt formations of the Gulf of Mexico. Work will also continue to improve advanced diagnostic systems, including those that use magnetic resonance imaging and computer assisted tomography to help locate oil-bearing structures. Studies will also continue to portray the flow patterns of oil and to predict patterns of oil-bearing rock distribution, both horizontally and vertically, to help guide “infill” drilling (between existing wells). Basin-wide analyses are also an important aspect of this program with activities in FY2000 continuing to examine hydrocarbon creation and flow patterns in South Central Appalachia formations and the onshore Gulf of Mexico formations in Alabama and Mississippi.

Chemical, gas flooding, and other enhanced recovery processes that produce oil otherwise left behind by conventional processes will continue to be developed along with computer modeling techniques that can simulate the likely production improvements possible with these technologies. Microbial processes will continue to be developed that extract surfactant (detergent-like) and other oil recovery agents from waste products, thereby minimizing disposal requirements and costs.

This portion of the budget also includes DOE support of the industry-led Petroleum Technology Transfer Council and its 10 regional centers.

Effective Environmental

Protection

FY1999 - \$10.02 million

FY2000 - \$10.82 million

- This effort, combined with similar activity in the Natural Gas program, has as its objective the continued protection of the environment while decreasing the costs of environmental compliance. Included in this program are efforts to streamline regulations, especially where Federal, State, and local requirements overlap, to provide scientifically-sound risk assessments to assist the Environmental Protection Agency and states make cost-effective decisions regarding the release of particulate matter and other pollutants, and to develop lower cost compliance technologies especially for produced water treatment, air emissions controls, remediation, and oil field waste management.

Other Fossil Energy Research and Supporting Activities

In addition to its primary R&D efforts, the Office of Fossil Energy sponsors other types of research and supporting programs including:

Cooperative Research and Development

FY1999 - \$11.00 million FY2000 - \$10.00 million

- This funding provides the federal share of support (up to 50%) for jointly sponsored research programs at the University of North Dakota Energy and Environmental Research Center and the Western Research Institute.

Advanced Metallurgical

Processes

FY1999 - \$5.00 million FY2000 - \$5.00 million

- This program at the Albany (OR) Research Center address life cycle studies of materials production, disposal and recycling, including a key supporting role in the *Vision 21* program

Environmental Restoration

FY1999 - \$11.00 million FY2000 - \$10.00 million

- Funding assures the protection of workers, the public and the environment at DOE-Fossil Energy facilities and supports environmental remediation activities at several locations of former Fossil Energy R&D projects.

Fuels Programs

FY1999 - \$2.17 million FY2000 - \$2.17 million

- This budget supports regulatory functions still required of DOE to review natural gas imports and exports, exports of electricity, and the construction and operation of electric transmission lines which cross U.S. international borders, along with other regulatory responsibilities.

Program Direction and

Management Support

FY1999 - \$69.48 million FY2000 - \$72.08 million

- This category provides funding for salaries, benefits, and overhead expenses for managing the Fossil Energy program at headquarters, the Federal Energy Technology Center, and the National Petroleum Technology Office.

Plant and Capital Equipment

FY1999 - \$2.60 million FY2000 - \$2.00 million

- Funding for the DOE field sites to repair, improve, or refurbish buildings.

Clean Coal Technology Demonstration Program

The Clean Coal Technology Program has established the technological foundation for a generation of cleaner and higher efficiency coal processes in the 21st century. Several of the first-of-a-kind demonstrations have provided a preview of technologies that could one day be enhanced and integrated into the *Vision 21* fleet of new coal-based energy facilities.

For example, three gasification combined cycle projects — in Tampa, FL; Terre Haute, IN; and Reno, NV — have provided valuable data on using gasification as a core technology for super-clean, enhanced efficiency power generation. A Clean Coal Technology Project in Kingsport,

TN, is demonstrating an improved way to convert coal-derived gases into liquid methanol, and could serve as an early model for an “energypex” process that would produce liquid fuels and chemicals, in addition to process heat and electrical power.

The 40 advanced projects that make up the Clean Coal Technology Program have a total cost of \$5.7 billion, of which DOE has committed \$1.9 billion. With all projects selected and all the necessary funding appropriated, the budget for the Clean Coal Technology Program depends largely on the pace of the remaining projects that require final funding allocations for construction and operation.

Currently, of the 40 projects in the program:

- 23 have completed test operations and have either been concluded, moved into commercially-financed operations, or are in the final stages of reporting results to the department;
- 7 projects are in design, permitting, or other pre-construction activities;
- 1 project is in construction, and
- 9 projects are in operation, generating test data.

Our Performance Goals for the Clean Coal Technology Program in FY2000 Include:

- *Completing demonstration of the 3rd integrated gasification combined cycle project (Pinon Pine in Reno, NV) using air-blown gasification and hot gas cleanup for improved efficiency, and*
- *Continued operation of another integrated gasification combined cycle plant (Polk Plant near Tampa, FL) to establish the engineering foundation for a new generation of 60% efficient power plants.*

In FY2000, only two projects are expected to have outstanding obligation commitments — the Clean Energy Demonstration Project (an integrated gasification combined cycle and fuel cell project now planned for southern Illinois) and the CPICOR combined steelmaking and power generation project planned for Geneva, Utah. DOE’s current projections are that neither of these two projects will require funding allotments from previous appropriations in FY2000, and consequently, \$246 million can be deferred into future years.

Strategic Petroleum Reserve

The Strategic Petroleum Reserve — the largest single inventory of emergency crude oil in the world — provides the United States with an effective response to interruptions in the supply of crude oil. The Reserve currently holds just over 561 million barrels of high-quality crude oil, an amount that is slightly lower than in recent years due to the 1998 exchange of the Reserve’s Maya oil for a lighter crude that is suitable for a greater number of U.S. refineries (adjustments because of quality differences resulted in 8.5 million barrels of oil being received in return for 11 million barrels of Maya crude).

An inventory of 561 million barrels provides about 60 days of net import protection, but by FY2000 because of rising imports, this is projected to decline to about 55 days.

The Strategic Petroleum Reserve also has just over 100 million barrels of unfilled cavern capacity in its salt dome storage sites along the Texas and Louisiana Gulf Coasts. Recently, in this period of excess oil supplies and historically low oil prices, DOE has intensified efforts to examine options that would take advantage of current market conditions to enhance our energy security by stockpiling additional oil in the Reserve.

The Administration's pledge to stay within the Balanced Budget Agreement has precluded a request for appropriations in FY2000 to purchase more oil for the Reserve; however, the Administration is exploring other options, such as leasing unfilled cavern space in return for crude oil. Recent commercial leases of underused pipelines, with payments to be made in the form of crude oil, are another mechanism that will add oil to the Reserve without requiring additional appropriations.

Our Performance Goals for the Strategic Petroleum Reserve in FY2000 Include:

- *Complete the Life Extension Program to ensure the long-term reliability, effectiveness, and operational readiness of the Reserve for the next 25 years, and*
- *Ensuring that the calculated site availability of 95% or greater with drawdown capability of 4.2 million barrels per day for a sustained 90-day period within 15 days of Presidential notice are achieved.*

In FY2000, the Strategic Petroleum Reserve budget will be made up of:

Facilities ***FY1999 - \$145.12 million*** ***FY2000 - \$144.00 million***

- This funding is for operating the four primary storage sites in the Reserve, including maintenance, security, drawdown and readiness testing. The department will complete the brine fill and decommissioning of the geologically unstable Weeks Island site in 1999 with 98% of the site's 72 million barrels of crude oil successfully removed and relocated to other sites. The FY2000 budget also includes the final allocation of funding for the complex-wide refurbishment and modernization program which has effectively extended the useful life of the Strategic Petroleum Reserve for at least another 25 years.

Management ***FY1999 - \$15.00 million*** ***FY2000 - \$15.00 million***

- This provides salaries and benefits for the 135 federal employees that oversee management and operations of the Reserve, along with funding for analytical support for policy decisions, the Reserve's program to pursue commercial leasing of underutilized distribution and cavern facilities, the oversight of geotechnical stability and mine integrity (at the Weeks Island site), and necessary environment, safety and health corrective actions.

Petroleum Logistics ***FY1999 - \$0*** ***FY2000 - \$5.00 million***

- This funding augments the current account balance of \$33 million which has been set aside to initiate drawdown activities (for example, to pay for terminalling throughput fees, electrical power for operating drawdown pumps, and increased manpower requirements) in the event of an energy supply emergency.

Naval Petroleum and Oil Shale Reserves

With the successful divestiture of the government's interest in the Elk Hills Naval Petroleum Reserve in California and the transfer of jurisdiction over the Naval Oil Shale Reserves in Colorado, the properties remaining under DOE authorities include:

- Naval Oil Shale Reserve No. 2, an undeveloped property in Uintah County, UT;
- Naval Petroleum Reserve No. 2 (Buena Vista Hills) in Kern County, CA, a producing oil field in which DOE collects lease royalties of about \$1.5 million annually; and
- Naval Petroleum Reserve No. 3 (Teapot Dome) in Natrona County, WY, a producing stripper well field operated directly by the department and expected to produce about 350 barrels of oil per day in FY2000.

DOE also owns and operates the Rocky Mountain Oilfield Testing Center (RMOTC), established in 1995 at the Naval Petroleum Reserve Number 3. During calendar year 2001, plans are to privatize this facility. RMOTC currently serves as a training center and a facility for demonstrating, testing, and evaluating new technologies and equipment in an operating oil field environment. In addition to appropriations, funding for the center is also received through cost-sharing arrangements with industry, Federal, State and local governments, Native American tribes, trade associations, and others. Efforts will increase at RMOTC in FY1999 and FY2000 to demonstrate its potential as a profitable operation and to generate interest from the private sector in the privatization initiative.

The FY2000 budget for the Naval Petroleum and Oil Shale Reserves includes:

Naval Petroleum Reserves ***FY1999 - \$14.00 million*** ***FY2000 - \$0***

- In FY2000, approximately \$21.24 million will be necessary for final contract closeouts and settlement of equity shares at the Elk Hills Naval Petroleum Reserve, well plugging and environmental restoration necessary for the eventual abandonment of the Naval Petroleum Reserve No. 3, privatization of the Rocky Mountain Oilfield Testing Center (on the NPR-3 site), and funding for 39 federal staff. No new funding is required for the Naval Petroleum and Oil Shale Reserves. The Department will use unobligated prior year balances in the Naval Petroleum and Oil Sale Reserves account to fund these requirements, and therefore requires no new appropriations in FY2000.

Elk Hills Schools Lands Fund ***FY1999 - \$36.00 million*** ***FY2000 - \$36.00 million***

- The FY2000 budget provides for the 2nd of seven installments to be paid by the Federal Government to the State of California under terms of a Settlement Agreement that set aside nine percent of the net proceeds from the sale of the Elk Hills field for the State. DOE has deposited \$298 million in a contingent fund. Additional funds may be added when final ownership equity shares with Chevron are established and all of the costs associated with the Elk Hills sale are determined. Under the Settlement Agreement, the first five installments are for \$36 million each year, and any remaining balance is to be divided between two installments to be paid in FY2004 and FY2005.

